

Name:

15 minutes.

No calculator of any kind, other than your own mind, is allowed for this quiz.

Consider the following equation to solve for x , where $|\lambda| \ll 1$.

$$x = 3 + \lambda \sin x.$$

- (a) Find the perturbative solution for x up to second order in λ . [Hint: Your answer should involve only numbers (e.g., 3, $\sin 3$, $\cos 3$), and relevant powers of λ . Leave expressions such as $\sin 3$ or $\cos 3$ as they are, for this part.]
- (b) (No calculator is allowed.) Suppose $\lambda = 0.1$. Find the approximate numerical value of the perturbative solution for x , by using the *first order* solution of the previous part. You might also need to evaluate $\sin 3$ or $\cos 3$. If that is the case, then approximate $\sin 3$ by calculating $\sin(\pi - 0.14)$ up to first order in 0.14, and $\cos 3$ by calculating $\cos(\pi - 0.14)$ up to first order in 0.14.

For both parts (a) and (b), the following identities may be quite useful.

$$\sin(A + B) = \sin A \cos B + \cos A \sin B.$$

$$\cos(A + B) = \cos A \cos B - \sin A \sin B.$$

$$\sin \delta \approx \delta - \frac{\delta^3}{6}, \quad \cos \delta \approx 1 - \frac{\delta^2}{2}, \quad |\delta| \ll 1.$$